AGRICULTURAL LAND USE, PIPING AND GULLIES ACTIVITY IN THE HUERVA LOWER VALLEY (SARAGOSSA, SPAIN)

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1. Introduction

The variations in the total amount of surface used for arable crops both for dry farming and fallow land, with regard to the different "agricultural policies", have modified the natural dynamics of some processes such as piping and gullies activity in the Huerva lower valley (Saragossa) over the last 50 years.

2. Study Area and Gully erosion

The area of study focuses in the lower stretch of the Huerva Valley, tributary of the Ebro River at its right bank, opened in the Neogene gypsum facies of the Saragossa Formation. The climatic conditions in this sector are clearly semiarid, with precipitations around 320 mm per year, which are significantly irregular (Fig. 1), potential evapo-transpiration values of 1,200 mm -200 mm during the summer-, and a contrasted thermal regime -maximum absolute temperatures reaching 45ºC and minimum temperatures of under -10ºC-. Vegetation consists of steppe plants: on the gypsum silt accumulations settle more or less dense herbaceous formations (*Lygeum spartum* and *Stipa lascae*) due to progressive dynamics from derelict land. The soil on these gypsum-silt materials is weakly developed, *Entisol* type, with a certain depth, a poorly differentiated profile and, in most farmed land cases, it is quite pervious, with a weak structure, abundance of nitrogenous matter and a high biological activity. Cereal is this soil's agricultural use and its prevailing crop is wheat.

The Huerva's tributaries along this stretch are *vales*, flat-bottom valleys, filled basically with Holocene gypsum silts, with some rows of gypsum and limestone boulders and crossed by gullies with vertical incisions (1500 BP, Peña et al., 2000). Gully development over the last 1500 years triggered by a combination of human-induced land cover changes and extreme rainfalls have been documented (Faulkner, 1995, in southern Spain; Peña et al. (2000) in the Ebro Basin; Poesen et al. (2000), in Belgium). In Northeast Spain, particularly in the almost completely cleared out cultivated steppe land of the Inner Ebro Basin, gullying is a characteristic and widespread phenomenon, incising and dissecting the flat valley bottoms built up by Quaternary sediments (Ries and Marzolff, 2003).

The Vales Gully presents a high erosive activity both in the headwaters of the main incision and in the secondary ones, which can be related to piping phenomena. In some cases the piping activity has been recognised as a importan process in the development of bandlands and gully systems in other semiarid areas -in Etiopía (Bull, 1977), in Southeast Spain in dispersive marls (Harvey, 1982; López Bermúdez and Romero, 1989; Faulkner et al., 2003) and in some flat bottom valleys (Ries and Marzolff, 2003) or in Bardenas (Desir y Marín, 2006) in the Ebro Basin-.

The presence of easily dispersible silty soil, of scarce plant cover, of flat topography accelerating water infiltration -favoured by surface cracks-, of a water gradient facilitating the mechanical erosion of water… are some of the factors that help understand the piping dynamics (Gutiérrez et al., 1988).

3. Results and conclusions

Aerial photographs have been analysed to measure temporal changel in length, area or volume of gullies (Burkard and Kostaschuck, 1995; Nachtergaele and Poesen, 1999; Gabris et al, 2003; Martínez Casasnovas, 2003; Vandekerckhove et al, 2003). Another solution consists of combining high altitude aerial photo data with field data (Vandaele et al, 2003). In the study area have been anlaysed aerial photos of three distinct dates, 1956, 1984 and 1991.

The evolution observed over the last 50 years in the total hectares intended for dry farming and fallow land in the municipality of Botorrita (Fig. 3) does not differ from the patterns followed by the Spanish dry farming cereal; the few changes that have been introduced are always due to incentives relating to the present moment that have been supported by the Public Administrations. Thus, the increase of the surface used for growing wheat during the 50's, for instance, was backed by this cereal's preferential price policy. Nevertheless, in the 50's, the pipes'activity is absolutely evident under natural conditions and in the Vales Gully a functional piping can be seen, which is responsible for the growth of the largest gullies of the studied period (Fig. 2, 1956). At the end of the sixties, the wheat production had largely exceeded the needs of the inner market, which oriented the agricultural policy towards other cereals. In 1967, a series of measures were implemented in order to subsidize the wheat replacement for forage and fodder grains, especially maize and barley. High prices were fixed to these, which every time became nearer to those of wheat. On the one hand, old wheat fields were being replaced for barley and, on the other hand, new lands were being ploughed and gullies and pipes were anthropically refilled. This situation lasts as far as the eighties (Fig. 2, 1984). The solid boost experienced by the cultivated surface from the decade of the seventies leads to thinking that the sealing was a standard practice.

IV International Symposium on Gully Erosion. J. Casalí and R. Giménez (Eds.)
 ISBN 978-84–9769-198-7

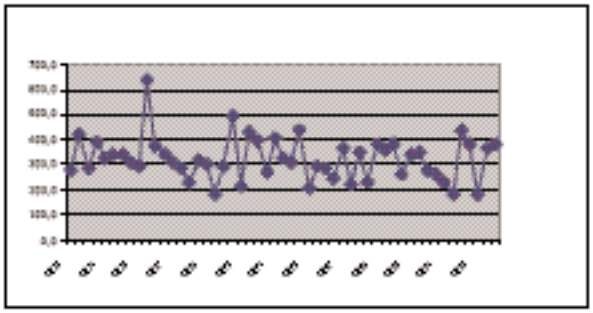

Fig. 1. Annual precipitation in mm (1950-2000)

The last stage starts with Spain's integration in the EEC, in which the markets'common organization is accompanied by a subsidies policy for those lands traditionally producing grain that should be left untilled for a five-year period, in an attempt to slow down the surplus of some products. This temporary dereliction of land reactivates the opening of pipes, which evolve naturally, without any anthropic intervention. Even though refilling may be done frequently, they are reformed during the next rainy season developping an incised channel with accelerated formation of lateral rills (Foster, 1986). The new incentives to compensate income losses (case of the hard wheat in Saragossa) result, only temporarily, in an increase of the cultivated land and in a brake on erosion. This fact can be confirmed in Figure 2 (1991), in which the potential activity of the process follows the gullies'beds in 1956, having broken the 1984 "sealing" and taking up again their natural dynamics (2,05m^2 in three months -Barrón et al., 1995-), which is periodically interrupted due to the increase of cultivated surface, coinciding with a certain dereliction of the farming.

Fig. 2. Gully activity evolution (1956-1991)

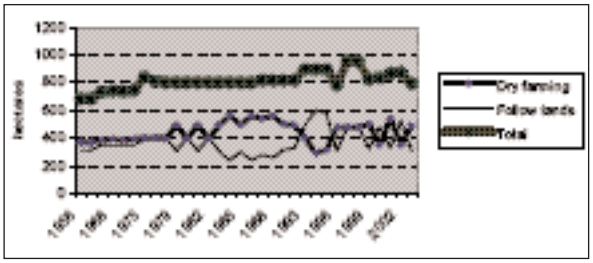

Fig. 3. Variations in the amount of surface used for arable crops both for dry farming and fallow land.

It can be therefore concluded that the piping dynamic and the gully erosion under the above-mentioned environmental conditions has been cyclically modified in connection with the different agricultural policies: from the pipe-sealing times -with rubble, plastics, earth…-, thus increasing the surface intended for crops, up to other stages in which the piping and gullying morphodynamic is clearly predominant.

Acknowledgements: The authors wish to thank Mr. Enrique Boldova, owner of the land of Las Vales Gully headwaters, for every facility he has kindly given to us.

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